Ultraporous interweaving electrospun microfibers and their cellular response

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ABSTRACT

In the field of tissue engineering, integration of micro-porosity, nano-topogaphical features and weattability into one three-dimensional (3D) scaffold remains a challenge.Here we report that a nanoscale immiscible polymer blend solution electrojet can assemble into ultraporous interweaving microfibers. The hierarchical porosity influenced cell infiltration, proliferation and differentiation significantly.

Methods

The polymer solutions were prepared by dissolving PCL (Mw 70 000–90 000, Aldrich) and PEO (Mw 900 000, Aldrich) in DCM/DMF (3:2) at room temperature and the homogeneous solutions were used for electrospinning under the following conditions: applied voltage 18 kV, feeding rate 1mL h^{-1}, and distance between the tip of the needle and collector 12 cm. The experiments were carried out at room temperature, and the relative humidity was between 30% and 60%. The morphology, crystallinity, surface chemistry and wettability of these fibers were studied by scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), X-ray diffraction (XRD), X-ray photoelectron spectrometry (XPS), and contact angle (CA) measurements. The NIH3T3 cell viability and proliferation was measured by LDH and MTS assay, cell attachment and infiltration were assessed by confocal microscopy.

RESULTS

Multi-lamellar cylindrical structure was originated from a blend of PCL and PEO in DCM/DMF mixed solution when the ratio between each component reached a threshold and where the electrospinning parameters were delicate controlled. The morphology, crystallinity, surface chemistry and wettabilities were characterized to understand the mechanism of formation. The interplay of the two semi-crystalline polymers and the pair of solvents/non-solvents with the electrospinning processing parameters was found to be critical for the formation of the unique structure.(Fig 1) [1]

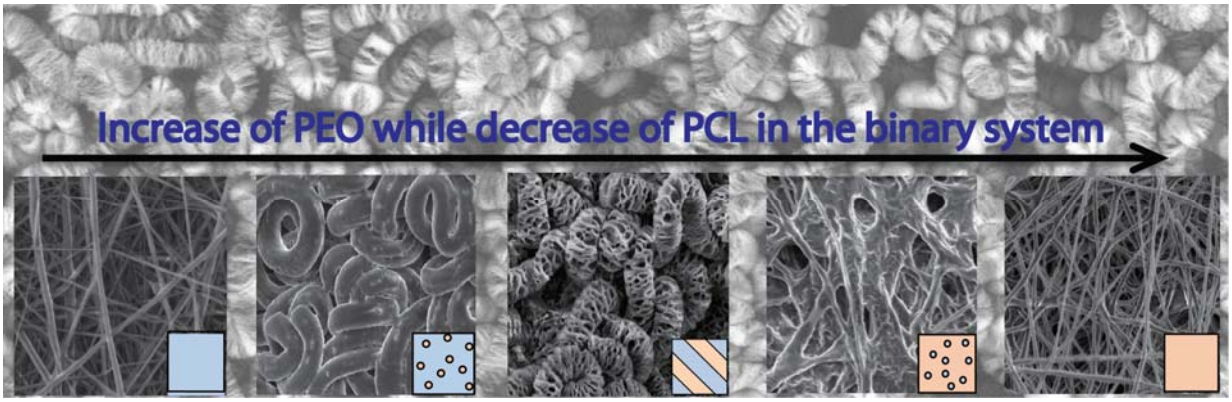

Fig. 1

The hydrophilic, hierarchically porous fibers were appilied in culturing fibroblasts and studied the cell infiltration and colonization. Compared to the tight-packed, hydrophobic PCL scaffold, the hydrophilic, micro-porous fibers enhanced the cell infiltration and colonziation significantly. Moreover, the unique nano-topographical environment that may stimulate cells in a drastically different manner from that of

traditional solid, smooth electrospun fibers, which holds great potential in reconstructing tissues that require strong contractile forces.(Fig 2) [2]

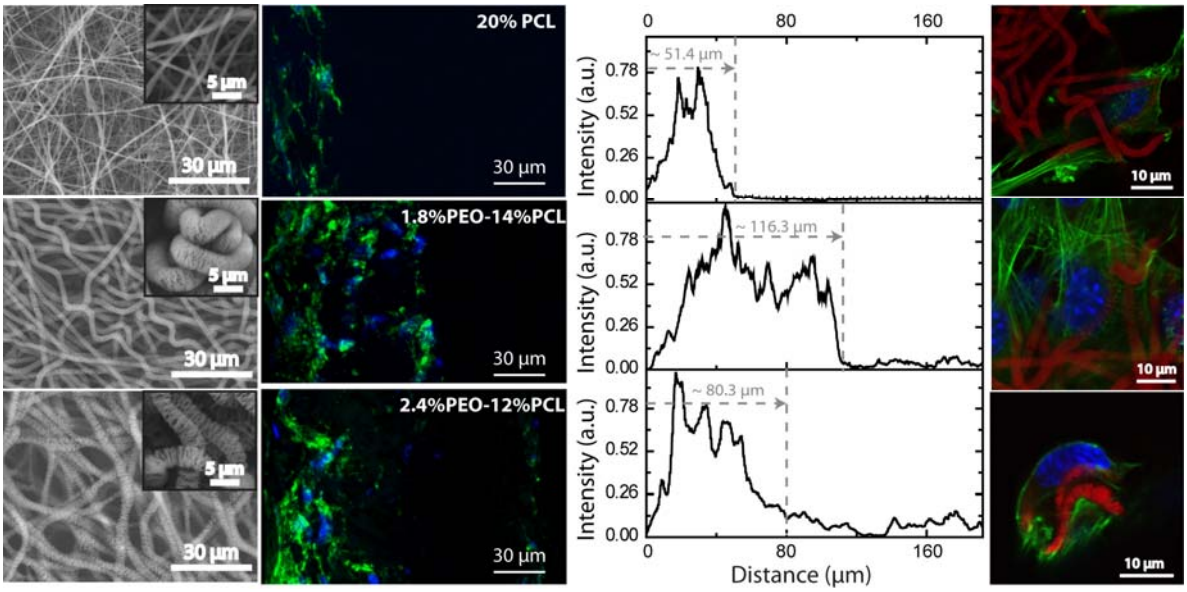

Fig. 2

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References

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